Descriptions of *Otukaia crustulum* new species (Gastropoda: Trochoidea: Calliostomatidae) and *Margarites huloti* new species (Gastropoda: Trochoidea: Trochidae) from a methane seep area off Chile

Claude Vilvens
Rue de Hermalle, 113
B-4680 Oupeye
BELGIUM
claude.vilvens@prov-liege.be

Javier Sellanes
Universidad Católica del Norte
Facultad de Ciencias del Mar
Larrondo 1281
Coquimbo
CHILE
sellanes@ucn.cl

ABSTRACT

Two new species of Trochoidea are described from a methane seep area off central Chile (~36°S). *Otukaia crustulum* new species is compared with similar calliostomatid species such as *Otukaia kiheiziebisu* (Otuka, 1939), *O. eltanini* Dell, 1990, and *Calliostoma jacquelinae* McLean, 1970. The new species is separated from these similar species by convex whorls bearing a prominent abapical cord and an almost invisible adapical cord, and five spiral cords on the base. *Margarites huloti* new species from the same locality is compared with similar margaritine species, such as *M. shinkai* Okutani, Tsuchida and Fujikura, 1992, *M. salmonea* (Carpenter, 1864), and *Solariella tavernia* Dall, 1919, and with calliostomatid species such as *Calliostoma nudiusculum* (von Martens, 1881), *C. magaldii* Caldini and Guimarães-Prado, 1998 and *C. keenae* McLean, 1970. The new species differs mainly by the size of its shell, elevated spire, rather thick spiral cords on the whorls, numerous low spiral cords on the base and the narrow, funnel-shaped, umbilicus.

INTRODUCTION

The deep-sea malacofauna of Chile is still scarcely known. The bathyal (>200 m water depth) mollusks associated with the deep-sea shrimp fisheries off central Chile (31 to 35°S) were described by McLean and Andrade (1982). Among the 15 species observed, four belonged to the Trochoidea (sensu Bouchet et al., 2005), two of them belonging to the genus *Otukaia* (*O. chilena* (Rehder, 1971) and *O. delli* (McLean and Andrade, 1982) and two to the genus *Bathybembix* (*B. macdonaldi* (Dall, 1890) and *B. humboldti* Rehder, 1971).

The diversity of the Trochoidea from the coast of northern Chile (18 to 31°S) was subsequently studied by Véliz and Vásquez (2000). Their study covered the intertidal to the slope area, and among the 11 species reported, the same four species indicated by McLean and Andrade (1982) were mentioned for the bathyal region. Vilvens (2002) described *Zetela alphonsi* from 800 m depth from off Chiloé, farther south (~40°S).

Forcelli (2000) cited 27 species of Trochoidea for the Magellanic province, but almost always without considering their distributional range (except for *Calliostoma fonkii* (Philippi, 1860) (Figures 8–9), clearly reported for the Pacific side of the Magellanic province); some of these species are in fact described from or reported for the southwestern Pacific (e.g., *Calliostoma consimilis* (E. A.Smith, 1881)).

In relation to the shallow-water malacofauna of Chile, *Calliostoma fonkii* (Philippi, 1860) has been known from moderately shallow-water north to Peru and the Galapagos Islands (Keen, 1971). Several fossil species of the genus *Calliostoma* have been found in Miocene sediments from the Arauco Peninsula (~38°S), none with geological ranges extending to the Recent (Nielsen et al., 2004).

Recent dredge hauls taken 75 km NW off the Bay of Concepción have allowed the location of a previously unknown habitat at bathyal depths along the Chilean coast, a methane seep area (Sellanes et al., 2004) named Concepción Methane Seep Area or CMSA (Sellanes and Krylova, 2005). At methane-seep areas, as well as in other marine reducing environments, chemically reduced fluids are utilized as an energy source by free-living and endosymbiotic chemosynthetic bacteria in the synthesis of organic carbon (Paull et al., 1984). Furthermore, microbially-mediated oxidation of methane within the sediments facilitates production of carbonates that act as a cement, ultimately giving rise to reefs of carbonate-cemented mud. A diverse community benefits both from the food sources originating from chemosynthesis and from the shelter and substrate provided by the reefs (Sibuet and Olu, 1988).

About 30 species of mollusks have been recorded at the CMSA. Part of this assemblage is composed by several recently described species of chemosymbiotic bivalves (Holmes et al., 2005; Oliver and Sellanes, 2005; Sellanes and Krylova, 2005), and non-chemosymbiotic accompanying species (Sellanes, unpublished data). Among gastropods, five species of Trochoidea have been recorded, including *Bathybembix macdonaldi*, *Otukaia chilena*, *Zetela alphonsi*, and the two unnamed species proposed herein. In this paper we describe a species of *Otukaia* and a species of *Margarites* that have been collected at the CMSA.

MATERIALS AND METHODS

Material in the present study consists of specimens obtained living (lv) from the dredgings of R/V VIDAL GORMÁZ in various stations (stn) of the CMSA.

Abbreviations used for measurements are: H: shell height; W: shell width; HA: aperture height; TW: number of teleoconch whorls. Spiral cords of teleoconch of the shells are labelled as P1, P2, etc., for primary cords (P1 is the most adapical) and S1, S2, etc., for secondary cords (S1 is the most adapical).

Type specimens are deposited at Natural History Museum of Chile, Santiago (MNHNCL) and Institut royal des Sciences naturelles de Belgique, Bruxelles, Belgium (IRSNB).

SYSTEMATICS

We follow herein the suprageneric classification of Marshall (1995) and Bouchet et al. (2005) for *Calliostoma*, *Otukaia*, and other related genera. Other authors, however, use the classification of Hickman and McLean (1990) where Calliostomatinae is considered as a subfamily of Trochidae.

Superfamily Trochoidea Rafinesque, 1815
Family Calliostomatidae Thiele, 1924
Subfamily Calliostomatinae Thiele, 1924
Tribe Calliostomatini Thiele, 1924
Genus *Otukaia* Ikebe, 1942

Type Species: *Calliostoma kiheiziebisu* Otuka, 1939 (by original designation); Recent, off Japan.

Otukaia crustulum new species
(Figures 1–5)

Description: Shell of medium size for genus (height up to 15.6 mm, width up to 14.4 mm), conical to weakly coeloconoidal in shape; spire high, as broad as large, height about 2.4 to 3.5 times higher than aperture; umbilicus closed in adult shell.

Protoconch damaged on all available specimens, about 450 µm in diameter, probably encompassing 1 whorl, too eroded to state presence and shape of terminal varix.

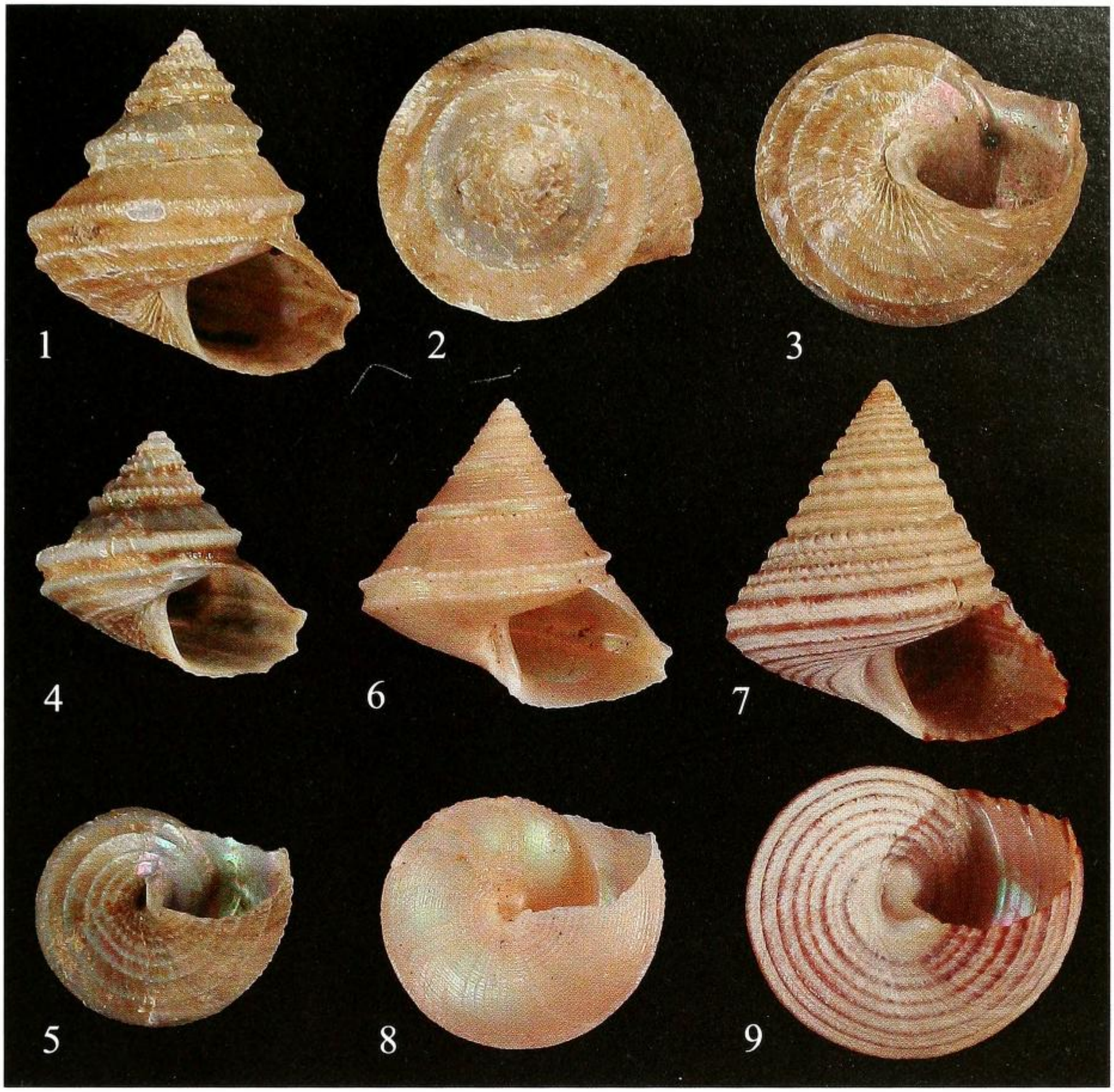
Teleoconch of up to 6 moderately convex whorls, bearing 3 spiral granular cords, adapical one the weakest, only poorly visible on last whorls; prosocline ribs on first 3 whorls connecting beads on spiral cords and very thin, axial lamellate threads between cords of the base. Suture visible, impressed, not channeled. First whorl of teleoconch convex, sculptured by 2 primary cords; P2 appearing immediately, granular; P1 appearing a quarter of whorl later, subgranular, weaker than P2; prosocline axial ribs in the intervals between cords, connecting beads of cords; interval between ribs 1.5 times larger than width of ribs. On second whorl, beads of P2 becoming thicker and sharp, isolated but connected by cord; beads of P1 axially elongated; P3 partly emerging from suture, granular; interval between axial ribs becoming 2 times larger than width of ribs; area between P2 and P3 concave. On third whorl, P1 is closer to suture, distance between beads of about 1.5 times width of beads; P2 the strongest, beads becoming axially elongated, distance between beads decrease to size of beads; P3 clearly visible, weakest, with small sharp beads. On fourth whorl, P2 closer to second abapical third of whorl, with beads less sharp, axially very elongated, and closely packed; beads of P1 becoming weaker, separated by interval 3 times larger than beads; axial ribs becoming obsolete. On fifth whorl, P1 becoming obsolete, almost disappearing; P2 thick, beads reducing to axial prosocline ribs. On last whorl, P1 virtually invisible; P2 very thick, producing carina; P3 much weaker, with small beads. Aperture subquadrate; interior of outer lip with lirae corresponding to external cords, producing strong angle at the rim; inner lip curved, projecting over umbilical area. Columella slightly curved, slightly oblique, without tooth. Base weakly convex, with 5 spiral cords; 2 innermost cords granular, interspace between cords similar in size to cords; 3 outermost cords subgranular, distance between cords two times larger than cords; very thin axial lamellate threads between cords, stronger in umbilical area. Color of teleoconch brownish-beige, tips of beads of spiral cords lighter in color.

Type Locality: Central Chile, 36°21.91′ S, 73°43.21′ W, 843–728 m, South Pacific Ocean.

Type Material: Holotype MNHNCL (201649) (lv), AGOR Vidal Gormáz, stn AGT 13, from type locality, 15.6 × 14.4 mm; Paratype IRSNB 30514 568 (lv), 10.4 × 11.0 mm.

Etymology: Of a cake (Latin), with reference to the shape of the shell whorls, which invoke the image of a baked cake. The genus-group name *Otukaia* was erected by Ikebe without definition of its etymology and without reference to its gender. We assume that the name is neutral.

Remarks: Absence of complete protoconchs in specimens from the type series prevents a definitive allocation of the new species in the Calliostomatidae. Provisional placement in this family, however, is prompted by the general shell shape, open umbilicus in the immature specimen, and similarities in the axial sculpture of the

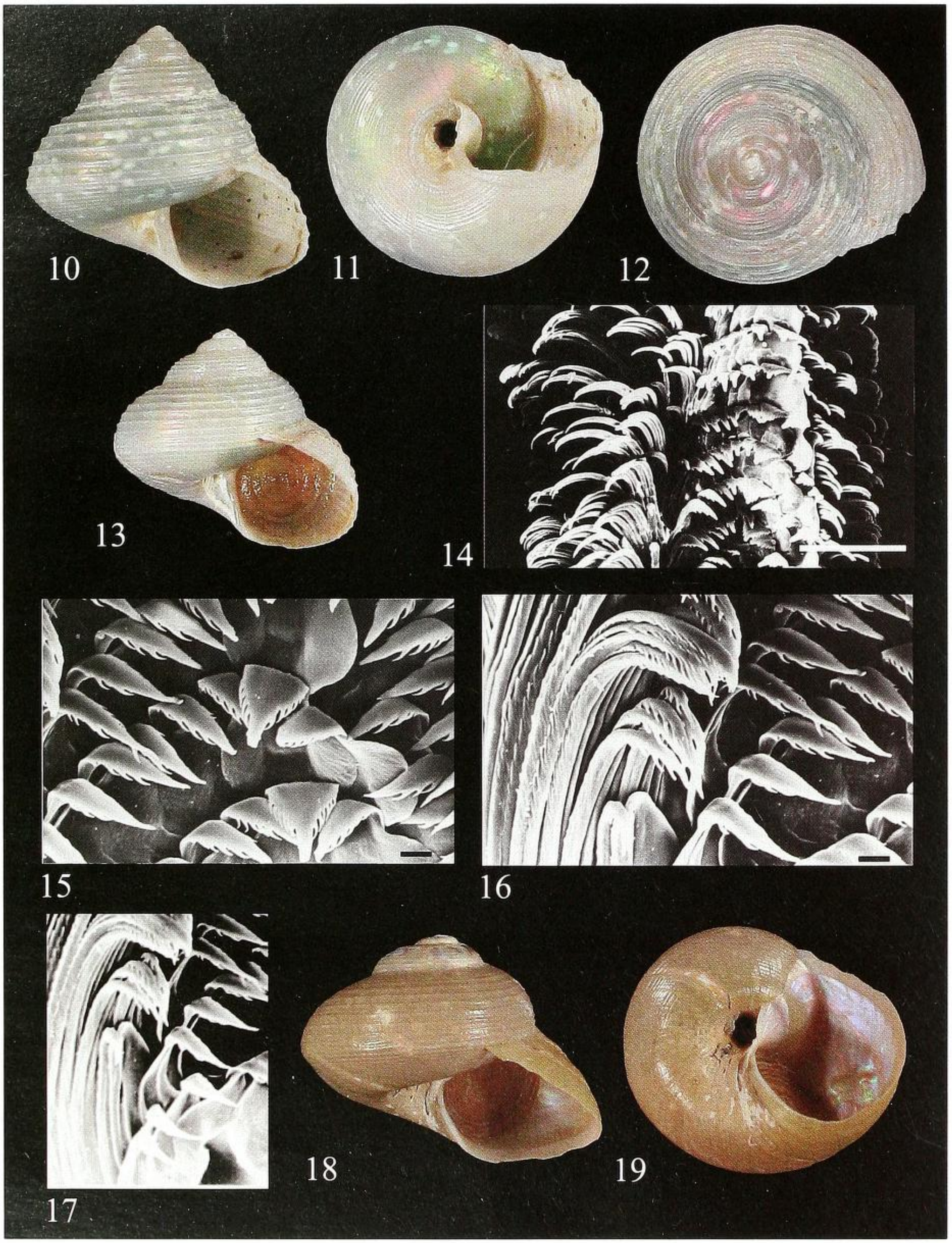


Figures 1–9. *Otukaia* and *Calliostoma* species. **1–5.** *Otukaia crustulum* new species, Central Chile. **1–3.** Holotype MNHNCL 201649, 15.6 × 14.4 mm. **4–5.** Paratype IRSNB 30514, 10.4 × 11.0 mm. **6, 8.** *Calliostoma jacquelinae* McLean, 1970, C.Vilvens coll., Galapagos Islands, 12.0 × 13.0 mm. **7, 9.** *Calliostoma fonkii* (Philippi, 1860), C.Vilvens coll., northern Chile, 16.0 × 14.5 mm.

early teleoconch whorls with other calliostomatids. Further studies including more complete specimens may reveal that the new species belongs in the Chilodontidae, tribe Calliotropini.

Among Calliostomatidae, the genus *Otukaia* Ikebe, 1942, seems to be the most adequate to include the new species. *Otukaia crustulum* new species weakly resembles *O. kiheiziebisu* (Otuka, 1939) from Japan (200–1000 m; Sasaki, 2000: pl.37, fig.108), but the median spiral cord P2 of this species is much thinner and the base bears more cords. The new species may also be compared to *O. eltanini* Dell, 1990, from the Pacific-Antarctic Ridge (915–1153 m; Dell, 1990: fig.168); this species, however, bears 4 primary, evenly distributed spiral cords on the last whorl, with 2 strong adapical cords, and 21 spiral cords on the base. *Otukaia crustulum* new species is rather similar to *Calliostoma jacquelinae* McLean, 1970, (Figures 6, 8) from the Galapagos Islands (150–350 m). Both species have a prominent abapical cord, but this latter species differs by having a strong, granular, subsutural primary cord P1, about 8 low smooth spiral cords between P1, and many more (about 30) narrow, smooth spiral cords on the base.

Family Trochidae Rafinesque, 1815
Subfamily Margaritinae Stoliczka, 1868
Tribe Margaritini Stoliczka, 1868
Genus *Margarites* Gray, 1847



Figures 10–19. *Margarites* species. **10–17.** *Margarites huloti* new species, Central Chile; **10–12.** Holotype MNHNCL 201650, 12.5 × 13.4 mm. **13.** Paratype MNHNCL 201651, 9.8 × 11.5 mm; **14–17.** Paratype MNHNCL 201651, features of the radula. **14.** General view. Scale bar = 100 μm. **15.** Rachidian and lateral teeth. Scale bar = 10 μm; **16.** Marginal teeth, lateromarginal plate and lateral teeth. Scale bar = 10 μm; **17.** Details of lateromarginal plate. **18–19.** *Margarites shinkai* Okutani, Tsuchida and Fujikura, 1992, holotype NSMT Mo 69635, Japan, 11.0 × 15.1 mm.

Table 1. *Margarites huloti.* Shells measurements in mm for the largest specimens (n = 4). Abbreviations are: H: shell height; W: shell width; HA: aperture height; TW: number of teleoconch whorls.

Character	TW	H	W	HA	H/W	H/HA
Range	4.00–5.00	9.80–12.50	11.50–13.40	4.60–5.30	0.85–0.94	2.04–2.43
Mean	4.55	11.45	12.50	4.95	0.91	2.31
Standard deviation	0.38	1.10	0.82	0.27	0.04	0.16

Type species: *Turbo helicinus* Phipps, 1774, by original designation; Recent, northern Atlantic Ocean.

Margarites huloti new species
(Figures 10–17)

Description: Shell of medium size for the genus (height up to 12.5 mm, width up to 13.4 mm), cyrtoconoidal in shape; spire moderately high, height about 0.9 times width and 2.0–2.4 times aperture height (Table 1); umbilicus narrow and deep. Protoconch about 550 µm wide, about 1 whorl, smooth, with a thin terminal varix. Teleoconch of up to almost 5 convex whorls, bearing spiral cords; adapical cords granular, abapical cords smooth. Suture visible, impressed, not channeled. First whorl of teleoconch convex, sculptured by 6 smooth, weak, low, very close, similar in size and shape primary cords (from P2 to P7); weak irregular growth lines. On second whorl, cords becoming stronger except P2 still weak; P1 appearing under suture, smooth; interval between cords of about half of width of cords. On third whorl, S1 appearing, weak, weakly granular; cords evenly spaced; distance between cords similar in size to cords; area between cords concave, with prosocline thin growth lines. On last whorls, S1 clearly granular, with axially elongated beads; P2 becoming weakly granular, with horizontally elongated beads; other cords smooth; distance between cords of about 1.5 times width of cords; P8 emerging from suture only on last whorl, close to P7; S2 sometimes appearing at end of last whorl, thinner and subgranular. Aperture oval; interior of outer lip with thin lirae corresponding to the external cords; inner lip weakly curved, projecting over the umbilicus. Columella straight, slightly oblique, without tooth. Base nearly flat or very weakly convex, with 20 to 25 smooth spiral cords; three innermost broader than others; interspace between cords smaller than cords, smooth or with very weak axial threads. Umbilicus narrow, funnel shaped, diameter about 10% of shell diameter in largest specimens, with crowded axial lamellae and no spiral cord within. Colour of protoconch and teleoconch iridescent grey, last whorl lighter; base whitish grey. Operculum horny, multispiral with a short growing edge. Radula rhipidoglossate; formula ca. 20 + (1) + 6 + 1 + 6 + (1) + ca. 20. Rachidian and lateral teeth similar in size and shape, with large, oval base and serrated overhanging cusps. Lateromarginal plate present. Marginal teeth thin, with long shaft and serrated cutting edges.

Type Locality: Central Chile, 36°21.91′ S, 73°43.21′ W, 843–728 m, South Pacific Ocean.

Type Material: Holotype: MNHNCL 201650 (lv), AGOR Vidal Gormáz, stn AGT 13, from type locality, 12.5 × 13.4 mm; paratypes: MNHNCL 201651 (5 lv), IRSNB 30514 569 (1 lv), all from type locality.

Etymology: Named after Andre Hulot, Belgian hydrobiologist, United Nations Development Programme, a scientist who initiated the marine science efforts in 1956 at the University of Concepción, Chile.

Remarks: *Margarites huloti* new species is superficially similar to another methane seep species *M. shinkai* Okutani, Tsuchida and Fujikura, 1992 (Figures 18–19) from Japan. This latter species, however, has a more depressed shell, whorls more convex, more numerous and thinner spiral cords on whorls, radula with 8 lateral teeth (in contrast to only 6 in the new species); in addition, the rachidian and lateral teeth in the Japanese species have a more slender base (Okutani, Tsuchida and Fujikura, 1992: figs. 15–16).

The new species seems rather similar to *Margarites salmonea* (Carpenter, 1864) from southern California, but the latter is much smaller for a similar number of whorls, has less spiral cords on the base, and a broader umbilicus. *Margarites huloti* new species may also be compared to *Solariella tavernia* Dall, 1919, from the Galapagos Islands. This latter species, however, has a smaller size for about the same number of whorls and bears more convex whorls with thinner spiral cords. The new species also resembles *Calliostoma nudiusculum* (von Martens, 1881) from the southwestern Atlantic, but the latter species differs from the new species by having a more depressed spire, less numerous spiral cords on whorls, and lacks an open umbilicus. The new species weakly resembles *Calliostoma magaldii* Caldini and Guimarães-Prado, 1998, from the southwestern Atlantic, but shells of this latter species have no umbilicus, are pinkish white, and have whorls and base bearing less numerous and thicker spiral cords. *Margarites huloti* new species may also be compared to *Calliostoma keenae* McLean, 1970, from the central eastern Pacific, but this latter species is slightly larger, has a more horizontally elongated aperture, and thinner and more numerous granular spiral cords on whorls.

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LITERATURE CITED

Bouchet, P., J. Frýda, B. Hausdorf, W. F. Ponder, A. Valdés and A. Warén. 2005. Part 2. Working classification of the Gastropoda. In: Bouchet, P. and J. P. Rocroi (eds.) Classification and nomenclator of gastropod families. Malacologia 47: 240–397.

Dell, R. K. 1990. Antarctic Mollusca, with special reference to the fauna of the Ross Sea. Royal Society of New Zealand Bulletin 27: 1–311.

Forcelli, D. O. 2000. Moluscos Magallánicos: Guía de moluscos de Patagonia y sur de Chile. Vázquez Mazzini Editores, Buenos Aires, 200 pp.

Keen, A. M. 1971. Sea Shells of Tropical West America, 2nd edition. Stanford University Press, Stanford, x + 1064 pp.

Hickman, C. S. and J. H. McLean. 1990. Systematic revision and suprageneric classification of trochacean gasteropods. Natural History Museum of Los Angeles County, Science Series, 35, vi + 169 pp.

Holmes, A., P. G. Oliver and J. Sellanes. 2005. A new species of *Lucinoma* (Bivalvia: Lucinoidea) from a methane gas seep off the southwest coast of Chile. Journal of Conchology 38: 673–681

Marshall, B. A. 1995. Calliostomatidae from New Caledonia, the Loyalty Islands and the northern Lord Howe Rise. In: Crosnier, A. and P. Bouchet (eds.) Résultats des Campagnes MUSORSTOM, Volume 14, Mémoires du Muséum national d'Histoire naturelle 167: 381–458.

McLean, J. H. and H. Andrade. 1982. Large archibenthal gastropods of central Chile: collections from an expedition of the R/V Anton Bruun and the Chilean shrimp fishery. Contributions in Science. Natural History Museum of Los Angeles County, Contributions in Science, 342, 20 pp.

Nielsen, S. N., D. Frassinetti and K. Bandel. 2004. Miocene Vetigastropoda and Neritomorpha (Mollusca, Gastropoda) of central Chile. Journal of South American Earth Sciences 17: 73–88.

Okutani, T., S. Tsuchida and K. Fujikura. 1992. Five bathyal gastropods living within or near the *Calyptogena*-community of the Hatsushima Islet, Sagami Bay. Venus 51: 137–148.

Oliver, P. G. and J. Sellanes. 2005. Thyasiridae from a methane seepage area off Concepción, Chile. Zootaxa 1092: 1–20.

Paull, C. K., B. Hecker, R. Commeau, R. P. Freeman-Lynde, C. Neumann, W. P. Corso, S. Golubic, J. E. Hook, E. Sikes and J. Curray. 1984. Biological communities at the Florida escarpment resemble hydrothermal vent taxa. Science 226: 965–967.

Sasaki, T. 2000. Trochidae. In: Okutani, T. (ed.) Marine Mollusks in Japan, Tokai University Press, Tokyo. 1173 pp.

Sellanes, J., E. Quiroga and V. A. Gallardo. 2004. First direct evidences of methane seepage and associated chemosynthetic communities in the bathyal zone off Chile. Journal of the Marine Biological Association of the United Kingdom 84: 1065–1066

Sellanes, J. and E. Krylova. 2005. A new species of *Calyptogena* (Bivalvia, Vesicomyidae) from a recently discovered methane seepage area off Concepción Bay, Chile (~36°S). Journal of the Marine Biological Association of the United Kingdom: 969–976.

Sibuet, M. and K. Olu. 1998. Biogeography, biodiversity and fluid dependence of deep-sea cold-seep communities at active and passive margins. Deep-Sea Research II 45: 517–567.

Véliz, D. and J. Vazquez. 2000. La familia Trochidae (Mollusca: Gastropoda) en el norte de Chile: consideraciones ecológicas y taxonómicas. Revista Chilena de Historia Natural 73: 757–769.

Vilvens, C. 2002. Description of *Zetela alphonsi* n. sp. (Gastropoda: Trochidae: Solariellinae) from Chile. Novapex 3: 61–64.